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BIAS IN THE COLLECTION OF MUSSEL SHELLS OPENED BY OYSTERCATCHERS

J. Speakman

The foods which are eaten by wading birds are of interest for a variety of different reasons - from studies of community structure, niche separation, resource depletion and carrying capacity, to individual food requirements, energy balance and survival. Only a limited amount of information on the prey selected can be obtained by direct observation of feeding birds. When more detailed information is required such observations must be supplemented, or replaced, by other methods. For some waders which feed on relatively large bivalve molluscs one potential technique is to recover the shells which remain at the site of each prey capture. This recovery technique has been used previously by many studies to infer diet choice of the Oystercatcher (*Haematopus ostralegus*) when feeding on cockles (*Cerastoderma edule*) and on mussels (*Mytilus edulis*) (Drinnan 1957, Sutherland 1982, Speakman 1984, Zwartz and Drent 1981).

Cayford has recently highlighted a potential bias which may occur with the recovery technique. This is that human searchers for shells may collect larger shells more reliably than small shells because they are more visible. Cayford (1988) assessed the extent of this bias by getting an assistant to distribute opened shells on a mussel bed and then searching for them. He found that for shells lying on the mud there was indeed a bias in collection towards larger shells. The extent of bias detected by Cayford (1988) however does not necessarily reflect the bias involved in recovering shells during studies of prey selection. Firstly, in Cayford's experiment shells were distributed at a very high density (300 in an area measuring 7m by 7m, i.e. over 6 per square metre) which greatly exceeds the density of shells opened and discarded by foraging Oystercatchers. Secondly the collector has a *a priori* knowledge of the numbers of shells in each size class and this may have influenced the searching behaviour. Finally Cayford spent a very long time (almost two hours) searching the small area for shells, "...until trampling of the mud made further searching unprofitable.", which far exceeds the time spent searching for shells over larger areas in previous studies.

In my previous study of the diet choice of the Oystercatcher (Speakman 1984), which was based upon the recovery of opened and discarded mussel shells, I performed a similar experiment to assess collector bias. The design of my experiment overcomes the above criticisms of Cayford's procedures. Firstly, marked mussels were distributed over a mussel bed measuring 20m by 20m, at a density of less than 0.4 per square metre. Variable numbers of each size class, between 12 and 20 per class, which were unknown to the collector prior to searching were used. Finally the area was searched for 20 minutes, which was the same time spent searching similar sized plots during the diet choice study.

The results of this experiment are illustrated in Figure 1. I discovered a bias in the collection towards larger mussels which was also subsequently found by Cayford (1988). However in my study mussels in the largest classes (51 to 60 mm) were approximately 3.8

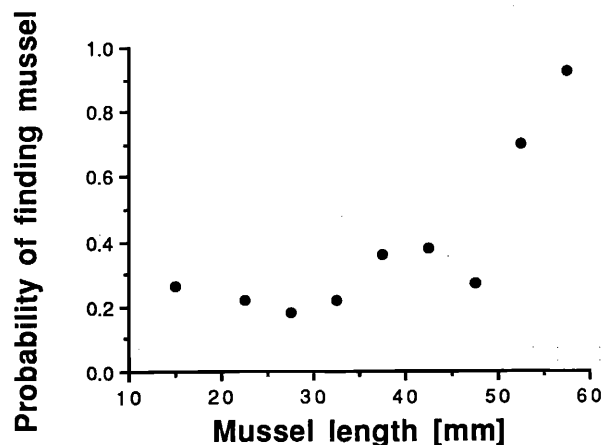


Figure 1. The probability of a collector recovering an opened mussel from the surface of a mussel bed, during a time limited search, plotted against mussel length.

times more likely to be found than mussels in the range 10 to 30 mm. This compares with a ratio of about 1.8x for the same size classes, for mussels recovered from the surface i.e. unburied shells, in Cayford's study (calculated from Figure 2: Carried shells - Class 5 (51 to 60 mm), 75% found; classes 2 and 3 (10 to 30 mm), 42.5% found, Ratio = 1.76. In situ shells, class 5, 55% found, classes 2 and 3, 30% found, Ratio = 1.83).

The differences in bias towards larger shells in the two studies probably reflect the different protocols which made finding small mussels easier in the Cayford study - that is high density of a known number of mussels in a small very intensively searched area. The dependence of the bias on the experimental protocol reinforces Cayford's suggestion that it is important for each observer to assess their own biases in each study. However it also suggests that the protocol used to quantitatively assess bias should match as closely as possible the collection procedures used in the relevant diet choice study. Cayford's conclusion that the effects of bias in shell collections are likely to be negligible is dependent upon the bias he detected and, as revealed in the current paper, this may be a gross underevaluation of bias for most studies which use searching procedures more closely matched by the test described here.

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BIAS IN THE COLLECTION OF MUSSEL SHELLS OPENED BY OYSTERCATCHERS: A REPLY TO SPEAKMAN

J.T.Cayford

John Speakman (1990) notes rightly that I had failed to refer to the test of mussel shell recovery bias presented in his PhD thesis (Speakman 1984). In doing so, Speakman has, however, made some slightly misleading interpretations of what I wrote in my original paper (Cayford 1988) and I clarify these points here.

Speakman states that "the extent of bias detected by Cayford (1988) does not necessarily reflect the bias involved in recovering shells during studies of prey selection". I agree and concluded my paper with the point that "because the extent of bias is as likely to differ between individual observers, it is important that each observer measures, and corrects for, his/her own bias regardless of the technique used".

Speakman makes three criticisms of my experimental design, namely that "shells were distributed at higher densities than those opened and discarded by foraging Oystercatchers; that the collector had a *priori* knowledge of the numbers of shells in each size class; and the time spent in searching for shells exceeded that spent searching for shells over larger areas in previous studies". Certainly these three features of my design differed from actual field conditions and procedures used by other workers. The main purpose of my study was, however, to explore the potential for bias in shell collections rather than to produce generalized quantitative predictions of bias for every previous study using similar methods. I clarified this in my discussion, by stating that "the extent of bias

found in this experiment is likely to be less than that in a real field study using the same technique (i.e. shell recoveries) because the observer had a *priori* knowledge of the number, approximate density and size-distribution of shells present; and the density of shells was very much higher than that found naturally".

Whilst the absolute density of shells on the mussel bed will in all probability influence the rate of shell recovery, only differences in the relative densities of different size classes could influence the probability of mussels of a particular size-class being found, independently of any size-dependent recovery bias. On the question of a *priori* knowledge, it is difficult to envisage circumstances in which a researcher studying Oystercatcher feeding ecology (which almost invariably necessitates making repeated shell collections) will not have some a *priori* knowledge of the approximate density and size-distribution of shells present on the bed prior to searching. If this is the case, an experimental protocol which fails to reflect this might actually overestimate bias. Clearly the amount of time spent searching per area of mussel bed could be critical if the extent of bias is negatively correlated with duration of searching, as might be expected. In this case Speakman is right to suggest that the protocol used to quantitatively assess bias should match as closely as possible the collection procedures used in the relevant diet choice study, i.e. where the results of the experiment are to be used to calibrate recoveries of shells made under field conditions. It was for just this reason that I quantified my recovery bias